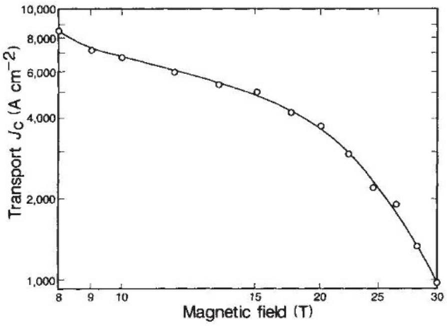
Current record in superconductors

SIR — The achievement of high transport critical currents in bulk high-T_c superconductors at high magnetic fields and temperatures is necessary for many applications of these new materials[1]. The recently developed melt-growth process[2–4] offers the potential for obtaining greatly enhanced transport critical current density, J_c, compared with sintered high-T_c materials[1]. We show here that high transport J_c can be achieved in bulk melt-grown $YBa_2Cu_3O_7$ (ref. 4) at magnetic fields up to 30 T, at liquid-nitrogen temperature. (This is well above the irreversibility field, typically quoted as ~6 T for $YBa_2Cu_3O_7$ at 77 K for field along the c-axis.) As shown in the figure, the transport J_c for mutually perpendicular current and magnetic field in the a–b plane was 1–8 kA cm^{-2} up to 30 T. We think that these are the highest d.c. transport J_c values yet reported for bulk $YBa_2Cu_3O_7$ at 77 K and high magnetic fields. Such a high J_c at these high fields has not been obtained in bulk bismuth- and thallium-based high T_c materials at 77 K because of the strong thermally activated flux creep in these systems.



Transport critical current density versus magnetic field for bulk grain-oriented $YBa_2Cu_3O_7$ at liquid-nitrogen temperature, with **B** perpendicular to the c-axis.

At a lower temperature of 4.2 K, the critical current exceeded the current capacity (200 A) of our vapour-cooled current leads, and we are able to determine only a lower bound for the transport J_c of bulk $YBa_2Cu_3O_7$ at 4.2 K of >22 kA cm^{-2} at 30 T. These data suggest, however, that in the intermediate temperature range between 20 and 40 K the transport J_c at high fields over 30 T may well reach practical levels ($>10^4$ A cm^{-2}). These results bode well for applications such as current leads operating between liquid nitrogen and liquid helium temperature. They also provide motivation for the difficult task of developing long conductors made of high-T_c material for high-temperature magnet applications.

The low-contact-heating measurements necessary to measure such high J_cs were made with high-quality silver contacts[5] and a high-current sample mount. An electric field criterion of 10 µV cm^{-1} was used to determine the critical current[6]. On cycling the field between 8 T and 30 T, the critical current was reversible to within the experimental precision of ± 5%.

The sample dimensions for these transport J_c measurements were ~6 × 1.7 × 0.6 mm, with ~3 mm between the voltage taps. The samples were fabricated using a liquid-phase processing method described in detail elsewhere[7]. In this process, sintered bars of $YBa_2Cu_3O_7$ are melted at 1,100 °C for 10–15 min to decompose the compound into Y_2BaCuO_5 and liquid. The melt is then cooled slowly (1–2 °C h^{-1}) from 1,025 to 925 °C, through the peritectic temperature[3]. Following the liquid-phase process, the samples were annealed in oxygen for 24 h at each of 500 °C and 400 °C. Further details on the measurements will be published elsewhere.

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1. Ekin, J.W. *Adv. ceram. Mater.* **2**, 586–592 (1987).
2. Jin, S., *et al. Appl. Phys. Lett.* **52**, 2074–2076 (1988).
3. Murakami, M., Morita, Doi, K. & Miyamoto, M. *Jap. J. appl. Phy.* **28**, 1189–1194(1989).
4. Salama, K., Selvamanickam, V., Gao, L. & Sun, K. *Appl. Phys. Lett.* **54**, 2352–2354 (1989).
5. Ekin, J. W. *et. al. Appl. Phys. Lett.* **52**, 1819–1821 (1988).
6. Ekin, J. W. *Appl. Phys. Lett.* **55**, 905–907 (1989).
7. Selvamanickam, V. & Salama, K., *Proc. MRS Meet.* **169**, 279 (1990).

Gas hazard on Vulcano Island

SIR — Baubron *et al.*[1] used data acquired during a single survey of CO_2 from soils around Vulcano Porto to define the gas hazard and the origin of the examined gases. Other groups, coordinated by the National Group for Volcanology, the Institute of Geochemistry of Fluids of the CNR and the Institute of Mineralogy Petrography and Geochemistry of the University of Palermo, have been carrying out geochemical and gas-hazard monitoring since 1977 on the island of Vulcano[2–8].

Between 1984 and 1990, 45 soil CO_2 surveys were carried out in the area between the base of the active cone of the Fossa and the walls of the surrounding caldera, where the gas hazard is higher because of terrain morphology and population density. In these surveys, CO_2 fluxes from the ground were measured according to the method developed in ref. 3. Soil CO_2 measurements were carried out on a sampling grid of 50 points distributed over an area of 2.2 km^2. Unlike Baubron *et al.*, a homogeneous grid was used because degassing from soils is spatially dishomogeneous, being mainly controlled by tectonics[9].

A wide range of fluxes, up to three orders of magnitude, has been measured. Maximum output was normally found at the base of the Fossa cone, close to the Faraglioni area. Any observed increase in CO_2 output is associated with an enlargement of the higher exhaling area. Temporal variations in unitary flux show different peaks at different amplitudes (Fig. 1). Two separate moments of maximum degassing in May 1985 and October 1987, can be identified. Significant variations in the activity (increased maximum temperature, seismicity and compositional variations, in fumaroles) were observed in both periods[5,7].

From June to September 1988, the frequency of observation and sampling was increased as a response to the increase in activity. In particular, measurements of soil CO_2 flux were intensified to four per month to check the gas hazard during the summer, when more than 15,000 tourists visit the island.

The CO_2 flux showed an increase from the first 10 days of August, up to a maximum value in October. Increased CO_2 output from the ground was again synchronous with variations observed in the composition and output of fumarole gases in the crater area (increased He, H, CO, reducing capacity, steam output)[4,5]. Increased seismic activity was also recorded in the last 10 days of August[4].

Our data clearly reveal that, although some peaks were recorded in the summer and autumn of 1988, the CO_2 output shows a general decreasing trend from October 1987 to March 1990. Furthermore, the mean values of eight continuous measuring points installed since the end of 1988 are relatively low, confirming that the gas hazard during 1988 was reduced. Thus, any reliable evaluation of gas hazard must be based on systematic monitoring, as isolated or sporadic recordings can lead to erroneous conclusions.

Our average unitary flux data allowed us to estimate CO_2 output from the area examined as 200 tons per day in September–October 1988, a value comparable to that emitted from the crater fumaroles[4]. In the same period, Baubron *et al.*[1] evaluated soil CO_2 output at 30 tons per day. As the size of the areas to which they refer is not indicated,

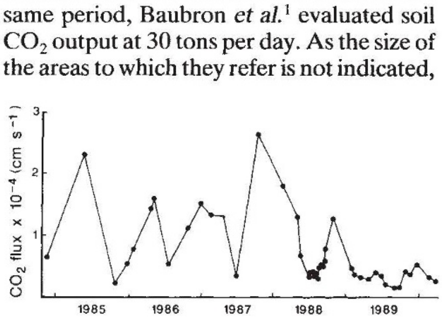

FIG. 1 Unitary flux of CO_2 from soil recorded at Vulcano Island from 1984 to March 1990. Despite an increase in activity observed since October 1987, CO_2 flux tends to decrease.